# Chemistry 129.01 - General Chemistry Workshop - Spring 2017

## Week #6

### ***Monday, February 27.*** Molecular Orbital Theory: Second Row Diatomic Molecules

Assigned reading: Sections 8.4

Today will finish our discussion of the Molecular Orbital Theory by looking at the MO energy diagrams of the second period diatomic molecules.

Read the rest of section 8.4, and pay attention to the Figures 8.35 and 8.36. Notice that, like with $H_2$ and $He_2$ MO diagrams, two atomic orbitals combine to form two molecular orbitals. One of the new orbitals goes down in energy (the bonding orbital), and one of the orbitals goes up in energy (the anti-bonding orbital). The names $\sigma$ and $\pi$ describe the symmetry of the MO.

It is important to look at Figures 8.37 and 8.38 carefully. These figures show how the ordering of the orbitals changes for different elements in the second period. The changes from expected to actual are due to a phenomenon known as "2s-2p orbital mixing". Why do think that "2s-2p orbital mixing" affects $O_2$ and $F_2$ less than it does $B_2$ ,$C_2$ and $N_2$?

Before Monday's class,

1. Draw the <u>atomic</u> orbital diagram of N and O. Do you expect the energy gap between 2s and 2p of N to be equal to, larger than or smaller than O's?

2. Sketch the MOs formed from the combination of two s orbitals.

3. How are $\sigma$ and $\pi$ MOs different?

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***Friday, March 3.*** Finish Session 8 of GHG Module

Assigned reading: Chapter 4, p. 170-172.

**Quiz today: Valence-Bond Theory, hybridization and multiple bonds.**

Today we'll discuss session 6 (What effect has infrared radiation on greenhouse gases?) of the greenhouse gas module in preparation for the Infrared spectroscopy lab next week. We'll talk about why molecules like $O_2$ and $N_2$ are not greenhouse gases while $CO_2$ and $CH_4$ are.

We'll also take a look at oxidation numbers of atoms and how to use them to determine what substances are reduced or oxidized in Redox reactions.

Before Friday's class,

1. Define the following terms:

   Oxidation number

   Oxidizing agent

   Oxidation–Reduction reaction

2. Take a look at Figure 6.3 (page 237), what's the wavelength range of infrared light? Is infrared light higher or lower in energy than visible light?

3. Heated lithium atoms emit photons of light with energy $2.961 \times 10^{-19}$ J. What's the color of light emitted?

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## Problem Set #1

Due Monday, March 6 (at the beginning of class). Late homework will not be accepted.

1. Explain why the peroxide ion, $O_2^{2-}$, has a longer bond length than the superperoxide ion, $O_2^-$.

2. Which of the following ions would you expect to be paramagnetic: $O_2^+$, $N_2^{2-}$, $Li_2^+$, $O_2^{2-}$? For those ions that are paramagnetic, determine the number of unpaired electrons. SHOW ALL YOUR WORK!

3. Carbon monoxide binds more strongly to hemoglobin than oxygen does. The hemoglobin-CO bond absorbs radiation of $1953 cm^{-1}$. Calculate wavelength (in nm) and the energy of the photon absorbed.

4. Determine the oxidation number of all the elements in the following compounds:
   (a) $N_2H_4$ (b) $SnCl_3^-$ (c) $C_2O_4^{2-}$ (d) $HNO_2$

5. Determine the oxidation number of all the elements and determine which element is reduced and which is oxidized in the following reactions:

   (a) $3\ Fe(NO_3)_{2\ (aq)} + 2\ Al_{(s)} \rightarrow 3\ Fe_{(s)} + 2\ Al(NO_3)_{3\ (aq)}$

   (b) $Cl_{2\ (aq)} + 2\ NaI_{(aq)} \rightarrow I_{2\ (aq)} + 2\ NaCl_{\ (aq)}$